Skeletal Evidence of Health and Disease in Pre-Contact Alaskan Eskimos and Aleuts

ANNE KEENLEYSIDE*
Department of Classics, Royal Holloway College, University of London, Egham, Surrey TW20 OEX, United Kingdom

ABSTRACT There have been relatively few paleopathological studies of arctic populations to date, compared to other regions of North America. Studies aimed at elucidating patterns of health and disease in arctic peoples prior to contact and assessing inter- and intraregional differences in disease patterns have been particularly few. In the present study, five pre-contact skeletal samples (N = 193), representing 4 Eskimo populations from northern coastal Alaska and 1 Aleut population from the eastern Aleutian Islands, were examined macroscopically for the following indicators of health status: cribra orbitalia, porotic hyperostosis, trauma, infection, dental caries, abscesses, antemortem tooth loss, periodontal disease, and dental attrition. In addition, archeological and epidemiological data were used to help reconstruct the health of these populations. The goals of the analysis were 2-fold: 1) to assess the pre-contact health of North Alaskan Eskimos and Aleuts in order to provide a baseline comparison for the post-contact health of these groups, and 2) to determine if any differences in disease patterns exist between the Eskimos and Aleuts that might be related to differences in their physical environment, subsistence patterns, and cultural practices. The analysis revealed that both groups suffered from a variety of health problems prior to contact, including iron deficiency anemia, trauma, infection, and various forms of dental pathology. Statistical comparisons of the 2 groups revealed that Eskimos and Aleuts had different patterns of health and disease prior to contact. Most notably, the Aleuts had a significantly higher frequency of cranial trauma and infracranial infection than the Eskimos, while the latter had a significantly higher frequency of enamel hypoplasia. An examination of the physical and cultural environment of the 2 groups reveals several possible explanations for these differences, including warfare, subsistence pursuits, and housing practices. The documentation of these differences indicates that variability in pre-contact disease patterns can be identified between hunter-gatherer populations living in similar environments and exhibiting similar general lifestyles. Am J Phys Anthropol 107:51–70, 1998.

KEY WORDS skeletal pathology; Arctic; prehistoric; hunter-gatherers; biocultural

In the last decade, a large number of studies of health and disease in pre- and post-contact populations from North and South America (Verano and Ubelaker, 1992; Larsen and Milner, 1994; Larsen, 1994) have been published. These studies have demonstrated the presence of a substantial

Contract grant sponsors: Social Sciences and Humanities Research Council of Canada (SSHRCC) Doctoral Fellowship, McMaster University School of Graduate Studies, Smithsonian Graduate Fellowship, Sigma Xi Grant-in-Aid of Research, Ontario Graduate Scholarship, and SSHRCC Post-Doctoral Fellowship.

*Correspondence to: Anne Keenleyside, Department of Classics, Royal Holloway College, University of London, Egham, Surrey TW20 OEX, United Kingdom.
E-mail: a.keenleyside@rhbnc.ac.uk

Received 2 June 1997; accepted 8 April 1998.

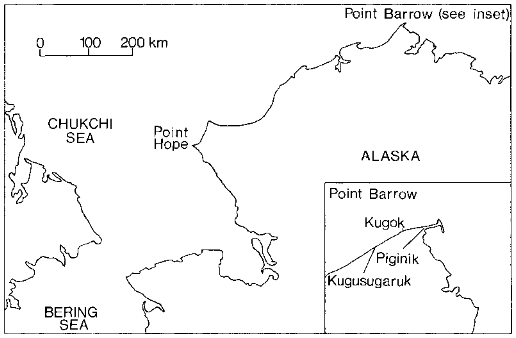

Fig. 1. Map of northern coastal Alaska.

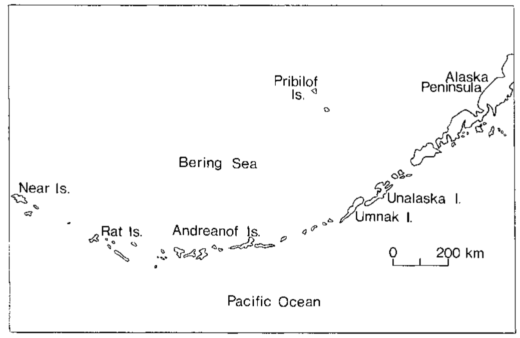

Fig. 2. Map of the Aleutian Islands.

pathogen load in some pre-contact populations and have revealed the existence of considerable variability in disease patterns in response to varying cultural factors within and between different geographic regions (Aufderheide, 1992; Ubelaker and Verano, 1992). Compared to other regions of North America, there have been relatively few paleopathological analyses of arctic populations. Studies of mummies from the Aleutian Islands (Zimmerman et al., 1971, 1981), frozen cadavers from Point Barrow (Zimmerman and Aufderheide, 1984) and St. Lawrence Island (Zimmerman and Smith, 1975), and skeletal remains (eg., Stewart, 1932, 1979; Lobdell, 1980; Merbs, 1983; Way, 1978; Salter, 1984) have yielded some information on Eskimo and Aleut health. However, there have been few investigations of large skeletal collections from the Arctic. Particularly few sought to elucidate patterns of health and disease in arctic populations prior to European contact and to assess inter- and intraregional differences in these patterns. The lack of such studies is unfortunate, since, as Fortuine (1986/87: 52) points out, “only by more clearly understanding the status of Native health prior to the arrival of whites can we fully appreciate the changes that followed.”

This article presents the results of an analysis of pre-contact Alaskan Eskimo and Aleut skeletal remains. Its aims are to 1) assess the health of the Eskimos and Aleuts prior to contact in order to provide a baseline comparison for the post-contact health of these groups, and 2) determine if any differences in disease patterns exist between these groups that might be related to differences in their physical environment, subsistence patterns, and cultural practices.

BIOCULTURAL CONTEXT OF THE SAMPLES

The Eskimo samples used in this study were excavated during the first half of this century from Point Hope and Point Barrow on the northern Alaskan coast (Fig. 1). Associated artifacts place the Point Barrow samples within the Birnirk period (A.D. 500–900) (Ford, 1959; Stanford, 1976), while the Point Hope sample dates to the late Thule period (A.D. 1400–1850) (Collins, 1929; Larsen and Rainey, 1948; Stanford, 1976; Utermohle, 1984). Archeological evidence indicates that the Thule phase developed directly from the Birnirk phase in northern Alaska (Anderson, 1984; Stanford, 1976).

The Aleut sample was excavated by Hrdlička in 1938 from the Chaluka site, a 4,000-year-old village site located within the present-day village of Nikolski in the eastern Aleutian Islands (Fig. 2). All of the skeletons are dolichocephalic “Paleo-Aleuts,” believed to have evolved into the brachycephalic “Neo-Aleuts” of the historic period (Laughlin, 1963). The Paleo-Aleut skeletons were recovered from the lower, middle, and upper levels of the site and date from ca. 1500 B.C. to 1000 A.D. (Laughlin, personal communication). Despite the temporal depth of these remains, archeological evidence from Chaluka indicates homogeneity in both material culture and diet throughout this period (Laughlin, 1963).

The northern coastal Eskimos occupy an almost flat coastal plain characterized by

long, cold winters and cool summers. Faunal remains recovered from Birnirk and Thule sites at Point Hope and Point Barrow indicate that the people relied on both marine and terrestrial resources, including whales, seals, walrus, polar bears, caribou, birds, and fish (Anderson, 1984; Dumond, 1987). These ancient Eskimos maintained large, permanent coastal villages as well as smaller, temporary settlements (Anderson, 1984; Rainey, 1947). Houses were small, single-room dwellings constructed of driftwood, whalebone, and sod, and heated by stone lamps (Anderson, 1984; Dumond, 1987). The basic item of clothing was a parka made from caribou skins (Spencer, 1984). Large, open boats, kayaks, and sleds were used for hunting and traveling (Spencer, 1984). These coastal people had a well-organized and widespread trade network (Anderson, 1984; Oswalt, 1979), and, at the time of contact, engaged in conflict with inland Eskimos on occasion (Burch, 1974; Rainey, 1947).

The Aleuts occupy a volcanic island chain characterized by rocky coastlines and moderate temperatures. Archeological evidence indicates that their ancestors exploited a wide variety of marine resources, including seals, sea otters, sea lions, whales, and numerous species of fish, shellfish, and birds (Laughlin and Aigner, 1975; Lippold, 1966; McCartney, 1984). Aleut settlements were located primarily on the coast, and consisted of large, permanent settlements and temporary camps (McCartney, 1984). Dwellings were large, semisubterranean structures constructed of driftwood and whalebones, covered with grass, sod, and skins, and were heated with stone lamps (McCartney, 1984). The Aleuts' traditional garment was a parka made of sea mammal or bird skins (Lantis, 1984). Hunting and traveling were by large, open boats and kayaks. Pre-contact Aleuts traded among themselves, and engaged in frequent conflict with one another and with neighboring Eskimos (Lantis, 1984; Veniaminov, 1984).

ENVIRONMENTAL AND CULTURAL DETERMINANTS OF DISEASE IN ESKIMOS AND ALEUTS

An analysis of indicators of physiological stress in Eskimo and Aleut skeletal remains may provide important information on their prehistoric health status. Skeletal and dental indicators of stress can reveal information about diet and nutritional status, infectious disease loads, developmental disruptions, and traumatic injuries. However, skeletal material also poses limits on our ability to reconstruct the health of past populations because 1) many diseases, particularly acute infectious diseases, leave no evidence in bone; 2) different diseases may produce similar skeletal changes, making accurate diagnosis difficult; 3) skeletal samples may be biased due to differential burial practices or preservation; and 4) skeletal samples consist of individuals who failed to survive and are therefore not representative of the populations from which they are derived (Ortner, 1992; Roberts and Manchester, 1995; Wood et al., 1992). To reduce the chance of error in interpreting the health of past populations, researchers have recommended the use of multiple indicators of stress in combination with archeological, historical, and epidemiological data (Goodman, 1993; Herring, 1992).

There is a link between human disease and the environment (Dubos, 1965; MacMahon and Pugh, 1970). In Dubos' (1965: 194–195) view, the transition from "latent infection into overt disease" occurs when environmental factors upset "the biological equilibrium normally existing between the host and the microbial agents." Epidemiological as well as archeological, ethnographic, and ethnohistorical data have been used to reconstruct health profiles of the Eskimos and Aleuts at the time of contact (Fortuine, 1989). Fortuine's examination of Eskimo and Aleut lifeways reveals several features of their physical and cultural environment that may have created conditions favorable for pathogenic microorganisms prior to contact. A brief review of Fortuine's (1989) findings is warranted.

Close contact with animals and their waste products predisposed Eskimos and Aleuts to a variety of zoonotic and parasitic infections. The practice of eating raw or undercooked foods placed them at risk of parasitic infections, while the ingestion of contaminated food and water increased the chance of infections of the gastrointestinal tract. Periodic

TABLE 1. Skeletal samples used in the study

Sample	Minimum no. of individuals	Location	Temporal position	References
Eskimos				
Kugusugaruk	42	Point Barrow	A.D. 500–900	Ford, 1959; Mason, 1930; Stanford, 1976; Stewart, 1959; Utermohle, 1984
Kugok	11	Point Barrow	A.D. 500–900	Ford, 1959; Stanford, 1976; Stewart, 1959
Piginik	9	Point Barrow	A.D. 500–900	Ford, 1959; Stanford, 1976; Stewart, 1959
Tigara	66	Point Hope	A.D. 1400–1850	Collins, 1929; Larsen and Rainey, 1948; Stanford, 1976; Utermohle, 1984
Total	128			
Aleuts				
Umnak Island	65	Umnak Island	1000 B.C.–A.D. 1500	Hrdlička, 1945; Laughlin, 1963, 1980; Turner et al., 1974; Utermohle, 1984
Overall total	193			

episodes of starvation provided the potential for vitamin and iron deficiencies to occur and increased susceptibility to infectious diseases. The nature of their environment and subsistence pursuits placed them at risk of traumatic injury, hypothermia, frostbite, and drowning (Fortuine, 1989).

The occupation of permanent winter villages by both Eskimos and Aleuts, coupled with the lack of sanitation in these villages, provided conditions ideal for the spread of disease. Permanent winter houses that were smoky, poorly ventilated, and filled with refuse also provided the opportunity for disease-causing microorganisms to flourish. The lack of personal hygiene and the custom of wearing skin clothing that was often infested with lice compounded the risk of infections (Fortuine, 1989).

Methods of transportation also put northern coastal Eskimos and Aleuts at risk for accidental injury or death. Among the Eskimos, falls from moving sleds were a potential cause of injury, while frequent water travel placed both groups at risk of drowning. Trade networks provided a good opportunity for the transmission of disease from one settlement to another, while the practice of warfare placed these groups at increased risk of injury, starvation, and death (Fortuine, 1989).

Given the risk factors outlined above, one might expect to see evidence in the skeletal remains of both the Eskimos and Aleuts of vitamin and mineral deficiencies resulting from periodic episodes of starvation, trauma resulting from subsistence pursuits and warfare, and infection due to crowded and unhygienic living conditions. In addition to these similarities, some diversity in their health profiles might also be expected due to the existence of some differences in their physical environment and cultural adaptations. This article addresses the question of whether variability in health profiles can be identified between hunter-gatherer populations living in similar environments and exhibiting similar general lifestyles.

MATERIALS AND METHODS

A total of 5 pre-contact skeletal samples, representing 4 Eskimo populations from Point Hope and Point Barrow on the northern Alaskan coast (Fig. 1) and 1 Aleut population from Umnak Island in the eastern Aleutian Islands (Fig. 2), were selected for analysis (Table 1). A minimum of 193 individuals, 128 Eskimos and 65 Aleuts, are represented in the samples. For 24 of these individuals, only the cranium and/or mandible was present, while the remaining 169 individuals had complete or nearly complete skeletons. The collections are currently being repatriated from the Department of Anthropology, National Museum of Natural History, Smithsonian Institution.

A detailed inventory was taken of all skeletons in the samples. The sex of each individual was determined using standard morphological criteria of the cranium and pelvic bones (Bass, 1987; Ubelaker, 1989). Subadult age estimates were obtained using dental eruption, diaphyseal length, and degree of epiphyseal union (Ubelaker, 1989), while adult age estimates were based on pubic symphysis morphology (Suchey and

TABLE 2. Age and sex distributions of the skeletal samples

	Eskimos				Aleuts			
Age	Males	Females	Unknown	Total	Males	Females	Unknown	Total
Subadult (<18 years)	1	2	10	13	1	0	4	5
Young adult (18–35 years)	20	24	0	44	4	4	0	8
Middle adult (36–50 years)	27	11	0	38	8	4	0	12
Older adult (50+ years)	23	10	0	33	17	23	0	40
Total	71	47	10	128	30	31	4	65

Katz, 1986; Suchey et al., 1988), sternal rib end morphology (Iscan et al., 1984, 1985), and maxillary suture obliteration (Mann et al., 1991). For the purposes of the analysis, adults were assigned to 1 of 4 age categories: 18–20 years, 21–35 years, 36–50 years, and 50+ years. The sex and age distributions of the samples are illustrated in Table 2.

All skeletal samples were examined macroscopically for the following health indicators: 1) porotic hyperostosis and cribra orbitalia, 2) trauma, 3) specific and non-specific infections, 4) enamel hypoplasia, 5) dental caries, 6) dental abscesses, 7) antemortem tooth loss, 8) periodontal disease, and 9) dental attrition.

All crania were visually examined for evidence of cribra orbitalia and porotic hyperostosis. Cribra orbitalia was scored as present in an individual if at least one orbit was affected. Lesions were further characterized as unremodeled or remodeled based on the criteria of Mensforth et al. (1978). Porotic hyperostosis was scored as present if the cranium exhibited both pitting and thickening of bone. Crania exhibiting pitting without thickening of the vault were classified as having ectocranial porosis (Mann and Murphy, 1990).

Traumatic lesions were classified by type (i.e., fracture, dislocation, amputation), location in the skeleton, size and location on each bone, and stage of healing (healing/healed vs. unhealed). Complications resulting from trauma were also recorded. Elements exhibiting evidence of infection secondary to a traumatic injury were included under the category of trauma.

Infectious lesions were classified by type (i.e., bone formation, bone loss, or both), location in the skeleton, size and location on each bone, and stage of healing (active vs. healing/healed). Specific features such as stellate scars, involucra, sequestra, and cloacae were also noted. Following the recommendations of the Skeletal Database Committee (Rose et al., 1991), long bones that were less than two thirds complete were eliminated from the calculation of trauma and infection frequencies unless they exhibited evidence of these conditions (no cases). Due to limited access to X-ray facilities, only a small number of specimens with infectious or traumatic lesions were radiographed.

Enamel hypoplasia was classified according to the Developmental Defects of Enamel (DDE) Index (Federation Dentaire International, 1982). Because of the variation in timing and susceptibility of defects between tooth types (Goodman and Armelagos, 1985), observations were recorded by individual tooth type. Hypoplastic defects were identified by visual examination and were scored as present or absent for each of the 6 anterior maxillary and mandibular teeth. All observed defects were further classified as either linear arrangements of pits, horizontal grooves, or both, and the total number of defects was recorded for each affected tooth. Those teeth that exhibited severe attrition resulting in the loss of more than one third of the tooth crown, heavy calculus deposits, severe caries, or trauma were excluded from the analysis.

Dental caries, abscesses, antemortem tooth loss, and periodontal disease were recorded by individual and by tooth/tooth socket. Dental caries and abscesses were identified by visual examination and were classified by location and size, according to the criteria utilized by Patterson (1984). Teeth were recorded as having been lost antemortem if there was clear evidence of some remodeling of the tooth socket. Periodontal disease was assessed by the shape and appearance of the interdental septa,

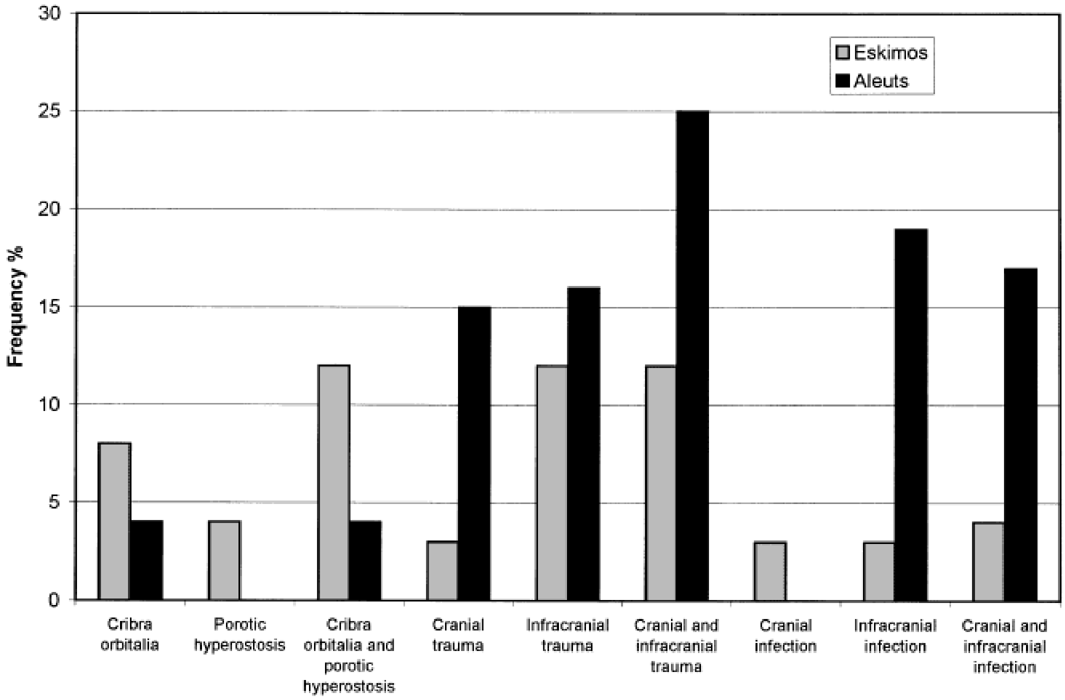

Fig. 3. Frequency of cribra orbitalia, porotic hyperostosis, trauma, and infection by individual.

following the methodology employed by Costa (1982). The degree of dental attrition was recorded for each tooth using Smith's (1984) 8-stage scale. To facilitate statistical analysis of the data, these stages were grouped into 4 larger categories following Beckett and Lovell (1994): no wear, slight wear (stages 1–3), moderate wear (stages 4–6), and severe wear (stages 7–8).

Following frequency calculations of each of the health indicators, statistical comparisons were made using the chi-squared test of independence, corrected for Yates continuity. Fisher's exact test was used when the number of cases was less than 20. Statistical analyses were performed using EpiInfo, Version 5. The analyses were done to determine whether any significant differences exist within and between the Eskimo and Aleut samples with respect to each indicator. For the purposes of these comparisons, the 4 Eskimo samples were grouped into 1 larger sample. The rationale for combining these samples is as follows: 1) the Birnirk people are believed to be the ancestors of the Thule from whom historic Inuit are descended (McGhee, 1976); 2) cultural continuity from the Birnirk to Thule to historic period is well-documented archeologically (Anderson, 1984); and 3) craniometric studies have indicated a close relationship between the Point Hope and Point Barrow Eskimos (Hrdlička, 1942; Zegura, 1975).

RESULTS

The frequency of cribra orbitalia, porotic hyperostosis, trauma, and infection by individual is presented in Figure 3. The occurrence of cribra orbitalia and porotic hyperostosis in Eskimos (10/118 and 4/103, respectively) was not significantly different from that in Aleuts (2/54 and 0/52, respectively). The lack of significant difference between the samples persisted when the conditions were combined (14/118 Eskimos vs. 2/55 Aleuts).

Only 3 of 103 individuals (2.91%) in the Eskimo sample had cranial trauma, consisting of healed fractures of the facial bones and mandible, and an unreduced dislocated mandible. In contrast, the Aleut sample had a significantly higher frequency of cranial

TABLE 3. Frequency of infracranial trauma and infection by element

	Humerus		Radius		Ulna		Femur		Tibia		Fibula		Total	
	A/O[1]	%	A/O	%	A/O	%	A/O	%	A/O	%	A/O	%	A/O	%
Trauma														
Eskimos														
Younger individuals	0/109	0.00	0/92	0.00	0/101	0.00	0/107	0.00	1/101	0.99	0/93	0.00	1/603	0.17
Older individuals	0/56	0.00	1/62	1.61	0/62	0.00	0/62	0.00	1/62	1.61	1/57	1.75	3/361	0.83
Total	0/165	0.00	1/154	0.65	0/163	0.00	0/169	0.00	2/163	1.23	1/150	0.67	4/964	0.41
Aleuts														
Younger individuals	0/23	0.00	0/24	0.00	0/24	0.00	0/24	0.00	0/23	0.00	0/17	0.00	0/135	0.00
Older individuals	1/76	1.32	1/57	1.75	0/64	0.00	1/78	1.28	0/74	0.00	1/60	1.67	4/409	0.98
Total	1/99	1.01	1/81	1.23	0/88	0.00	1/102	0.98	0/97	0.00	1/77	1.30	4/544	0.74
Infection														
Eskimos														
Younger individuals	1/109	0.92	0/92*	0.00	0/101*	0.00	2/107*	1.87	3/101*	2.97	2/93	2.15	8/603*	1.33
Older individuals	0/56	0.00	0/62	0.00	0/62	0.00	0/62*	0.00	0/62*	0.00	0/57	0.00	0/361*	0.00
Total	1/165	0.61	0/154*	0.00	0/163	0.00	2/169*	1.18	3/163*	1.84	2/150	1.33	8/964*	0.83
Aleuts														
Younger individuals	2/23	8.70	2/24	8.33	2/24	8.33	3/24	12.5	4/23	17.39	0/17	0.00	13/135	9.63
Older individuals	0/76	0.00	3/57	5.26	0/64	0.00	6/78	7.69	8/74	10.81	2/60	3.33	19/409	4.65
Total	2/99	2.02	5/81	6.17	2/88	2.27	9/102	8.82	12/97	12.37	2/77	2.60	32/544	5.88

[1] Affected/observed.
* Significant difference between Eskimos and Aleuts, $P < 0.05$.

trauma ($\chi^2 = 6.17$, $P = 0.0078$). Affecting 8 of 53 individuals (15.09%), the injuries consisted primarily of small healed depression fractures of the frontal, parietal, and occipital bones. The fractures were circular or oval-shaped, and were confined to the frontal bone in 4 individuals, the parietal bone in 3 individuals, and the occipital bone in 1 individual. Only 1 cranium exhibited more than 1 depression fracture. Significantly more males were affected in the Aleut sample (6/25 males) compared to the Eskimo sample (1/59 males) ($\chi^2 = 8.70$, $P = 0.0024$), while there was no significant difference between females (2/26 Aleuts vs. 2/37 Eskimos).

Thirteen of 112 individuals (11.61%) in the Eskimo sample had partly or completely healed fractures of 1 or more of the ribs, clavicles, scapulae, radii, tibiae, fibulae, and foot bones, while 9 of 57 individuals (15.79%) in the Aleut sample had partly or completely healed fractures of 1 or more of the ribs, radii, scapulae, humeri, femora, fibulae, pelvic, and hand bones. One individual in the latter sample had both cranial and infracranial trauma. There was no statistically significant difference between the 2 samples with respect to infracranial trauma by individual or by element (all major long bones combined) (Table 3). Similarly, when cranial and infracranial trauma were combined in order to assess the overall prevalence of trauma in the study samples, there was no significant difference between the 2 samples (16/128 Eskimos vs. 16/65 Aleuts).

Three of 104 individuals (2.88%) in the Eskimo sample showed evidence of cranial infection. In all 3 cases, the lesions were restricted to the mandible, sphenoid, zygomatic, maxillary, and/or temporal bones and were active at the time of death. In contrast, none of the 52 observable Aleut crania displayed any evidence of cranial infection, but the difference between the 2 samples was not statistically significant.

Infracranial infection involving 1 or more of the ribs, vertebrae, pelvic bones, and long bones was recorded in 3 of 112 individuals (2.68%) in the Eskimo sample. In 1 of these individuals, the cranium was also affected. In 2 of the individuals, the lesions were active at the time of death. In comparison to the Eskimo sample, the Aleut sample had a significantly higher frequency of infracranial infection by individual ($\chi^2 = 11.63$, $P = 0.0005$) and by element ($\chi^2 = 32.45$, $P < 0.001$) (all major long bones combined) (Table 3). Most of the infectious lesions were non-specific in nature, primarily involved 1 or more of the 6 major long bones, and occurred in 11 of 57 individuals (19.3%). Significantly more males were affected in the Aleut sample compared to the Eskimo

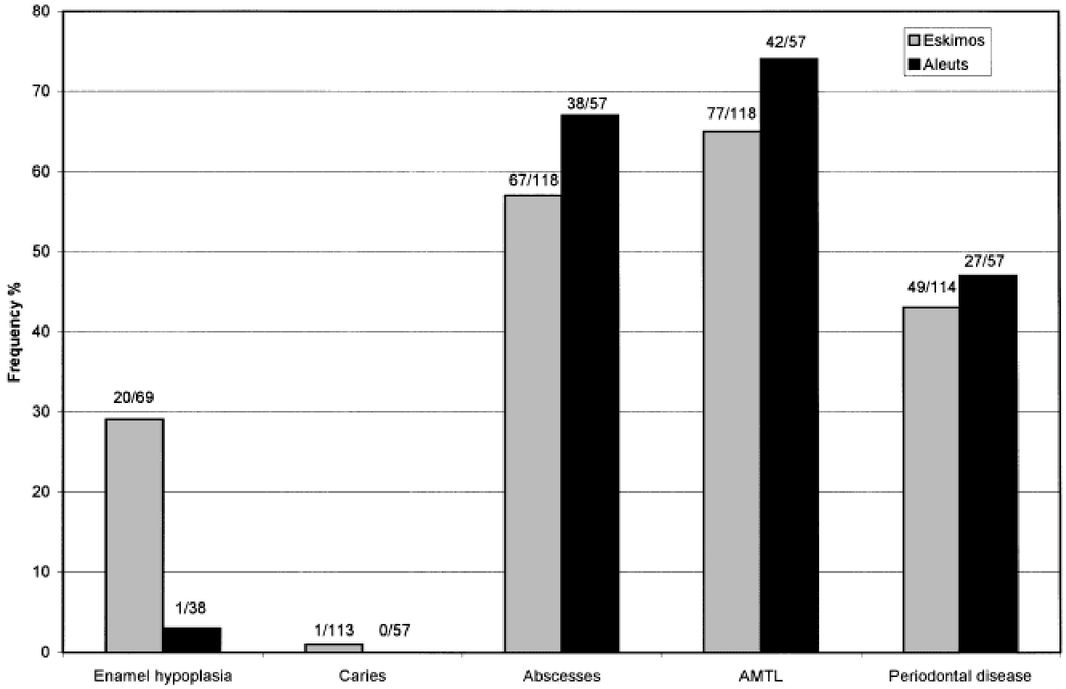

Fig. 4. Frequency of dental pathology by individual. AMTL = antemortem tooth loss.

sample (6/28 Aleuts vs. 1/63 Eskimos) ($\chi^2 = 8.13$, $P = 0.0031$), while there was no significant difference between females (5/25 Aleuts vs. 2/39 Eskimos). When cranial and infracranial infections were combined in order to assess the overall prevalence of infection in the study samples, the Aleut sample again showed a significantly higher frequency of infection compared to the Eskimo sample (11/65 Aleuts vs. 5/128 Eskimos) ($\chi^2 = 7.97$, $P < 0.01$), with significantly more males being affected (6/30 Aleuts vs. 3/70 Eskimos) ($\chi^2 = 4.56$, $P = 0.0199$) and no significant difference between females (5/31 Aleuts vs. 2/46 Eskimos).

The frequency of dental pathology by individual is presented in Figure 4. Antemortem tooth loss was the most common dental disease observed in both samples, affecting approximately 65% (77/118 individuals) of the Eskimo sample and 74% (42/57 individuals) of the Aleut sample. In contrast, caries was the least frequent condition, affecting none of the Aleuts and less than 1% (1/113 individuals) of the Eskimos. In both groups, significantly more older individuals (50+ years) had abscesses, antemortem tooth loss, and periodontal disease than younger individuals (<50 years). A statistical comparison of the 2 samples revealed that significantly more individuals in the Eskimo sample had enamel hypoplasia than in the Aleut sample ($\chi^2 = 11.71$, $P < 0.001$). In contrast, there were no significant differences between the 2 samples with respect to caries, abscesses, antemortem tooth loss, and periodontal disease.

The frequency of dental disease by tooth count is illustrated in Figure 5. Antemortem tooth loss was again the most common form of dental pathology in both samples, affecting approximately 18% (642/3,502 teeth) of the Eskimo sample and 18% (285/1,558 teeth) of the Aleut sample, while dental caries was the least common dental disease, involving none of the teeth in the Aleut sample and less than 1% (1/1,840 teeth) of the Eskimo sample. In both samples, older individuals (50+ years) had significantly more abscesses, antemortem tooth loss, and periodontal disease than younger individuals (<50 years). A statistical comparison of

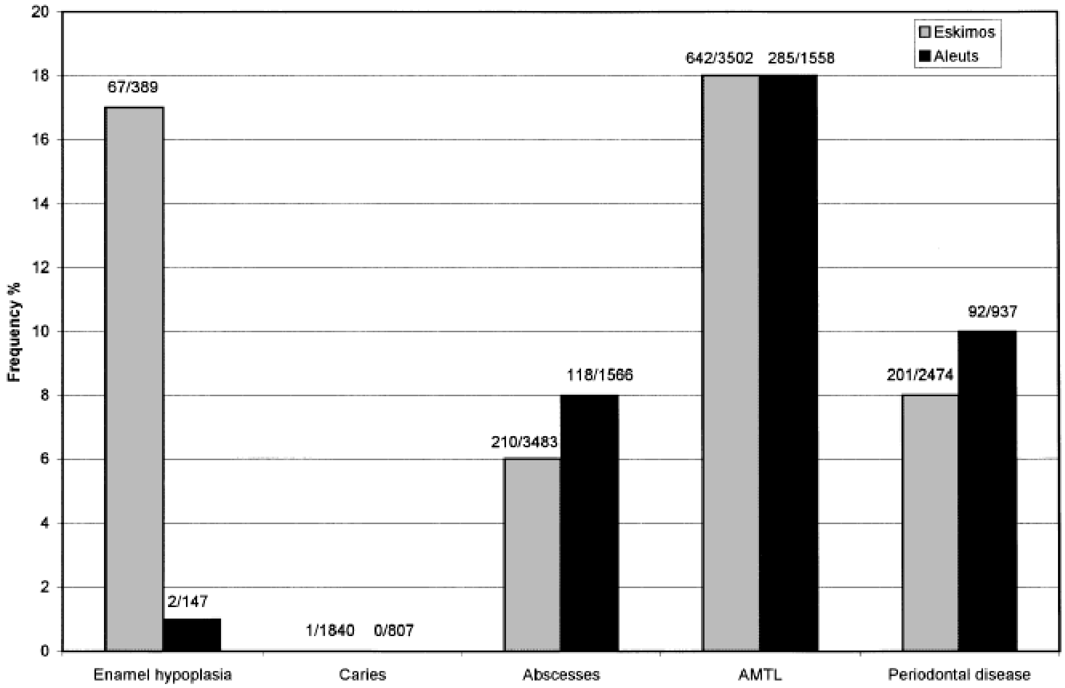

Fig. 5. Frequency of dental pathology by tooth. AMTL = antemortem tooth loss.

the Eskimo and Aleut samples by sex, age group, tooth type, jaw, and overall tooth count revealed a number of significant differences between the 2 samples with respect to enamel hypoplasia, abscesses, antemortem tooth loss, and periodontal disease (Table 4). Consistent with the comparison of the 2 samples by individual was the finding that the Eskimo sample showed significantly more enamel hypoplasia by tooth than the Aleut sample.

DISCUSSION

Stewart (1973: 19–20) hypothesized that the harsh arctic environment of Beringia was "unfavourable to the spread and perpetuation of disease germs" and that the earliest migrants to North America "passed through a germ filter, leaving behind whatever disease germs there were in the Old World." Black (1975) echoed Stewart's assertion, commenting that "the filtering effect of the Bering and Panamanian land bridges may have protected the people . . . from a number of diseases, including tuberculosis and malaria" (Black, 1975: 518).

One of the implications of Stewart's hypothesis is that native American populations enjoyed a virtually disease-free existence prior to contact with Europeans. As Fortuine (1986/87: 39) notes, however, "such an antiseptic life is a myth." Utilizing data from paleopathology, historical narratives, native traditional medicine, and modern medical research, Fortuine (1989) has demonstrated that the Alaskan Eskimos and Aleuts were not disease-free prehistorically. Rather, they suffered from a variety of health problems, some of them related to their unique environment and cultural practices, and others common to human populations everywhere (Fortuine, 1989). This finding is consistent with skeletal studies of native populations from elsewhere in the New World, which have indicated a substantial pathogen load prior to contact (Larsen, 1994; Verano and Ubelaker, 1992). It is also consistent with the results of the present study.

Cribra orbitalia and porotic hyperostosis

Cribra orbitalia and porotic hyperostosis in prehistoric Amerindian skeletal remains

TABLE 4. Dental pathology by tooth

Dental pathology	Sex		Age		Tooth type				Jaw		
	Males	Females	Younger individuals	Older individuals	Molars	Premolars	Canines	Incisors	Maxilla	Mandible	Total
Enamel hypoplasia											
Eskimos	34/184	33/169	62/340	5/49	—	—	41/180	26/209	13/187	54/202	67/389
	(18.48)[1]	(19.53)	(18.24)	(10.20)			(22.78)	(12.44)	(6.95)	(26.73)	(17.22)
Aleuts	2/93	0/53	2/72	0/75	—	—	2/83	0/64	0/66	2/81	2/147
	(2.15)	(0.00)	(2.78)	(0.00)			(2.41)	(0.00)	(0.00)	(2.47)	(1.36)
χ^2	13.16*	10.66*	9.67*	5.56*	—	—	15.77*	7.42*	3.52*	19.94*	22.54*
P	0.0003	0.0011	0.0019	0.0085	—	—	0.0001	0.0065	0.0236	0.0000	0.0000
Caries											
Eskimos	1/1,076	0/748	1/1,455	0/385	1/744	0/502	0/264	0/330	1/905	0/935	1/1,840
	(0.09)	(0.00)	(0.07)	(0.00)	(0.13)	(0.00)	(0.00)	(0.00)	(0.11)	(0.00)	(0.05)
Aleuts	0/454	0/322	0/307	0/500	0/329	0/261	0/115	0/102	0/385	0/422	0/807
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
χ^2	N.S.[2]	—	N.S.	—	N.S.	—	—	—	N.S.	—	N.S.
P	N.S.	—	N.S.	—	N.S.	—	—	—	N.S.	—	N.S.
Abscesses											
Eskimos	160/2,094	50/1,295	103/2,483	107/1,000	130/1,287	27/880	17/441	36/875	106/1,725	104/1,758	210/3,483
	(7.64)	(3.86)	(4.15)	(10.70)	(10.10)	(3.07)	(3.85)	(4.11)	(6.14)	(5.92)	(6.03)
Aleuts	60/755	43/695	19/557	89/1,009	64/559	15/398	13/203	16/406	61/809	47/757	108/1,566
	(7.95)	(6.19)	(3.41)	(8.82)	(11.45)	(3.77)	(6.40)	(3.94)	(7.54)	(6.21)	(6.90)
χ^2	N.S.	4.98*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
P	N.S.	0.0256	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Antemortem tooth loss											
Eskimos	401/2,064	241/1,342	240/2,506	402/996	308/1,315	114/879	51/438	169/870	340/1,735	302/1,767	642/3,502
	(19.43)	(17.96)	(9.58)	(40.36)	(23.42)	(12.97)	(11.64)	(19.43)	(19.60)	(17.09)	(18.33)
Aleuts	99/757	185/689	17/554	268/1,004	118/558	39/395	16/202	112/403	152/796	133/762	285/1,558
	(13.08)	(26.85)	(3.07)	(26.69)	(21.15)	(9.87)	(7.92)	(27.79)	(19.10)	(17.45)	(18.29)
χ^2	14.88*	21.18*	24.14*	41.32*	N.S.	N.S.	N.S.	10.73*	N.S.	N.S.	N.S.
P	0.0001	0.0000	0.0000	0.0000	N.S.	N.S.	N.S.	0.0011	N.S.	N.S.	N.S.
Periodontal disease											
Eskimos	161/1,420	43/948	62/2,008	139/466	121/803	37/719	21/341	22/611	82/1,196	119/1,278	201/2,474
	(11.34)	(4.54)	(3.09)	(29.83)	(15.07)	(5.15)	(6.16)	(3.60)	(6.86)	(9.31)	(8.12)
Aleuts	41/499	43/347	19/470	73/467	49/315	20/297	8/132	15/193	59/473	33/464	92/937
	(8.22)	(12.39)	(4.04)	(15.63)	(15.56)	(6.73)	(6.06)	(7.77)	(12.47)	(7.11)	(9.82)
χ^2	N.S.	24.04*	N.S.	25.97*	N.S.	N.S.	N.S.	4.9*	13.11*	N.S.	N.S.
P	N.S.	0.0000	N.S.	0.0000	N.S.	N.S.	N.S.	0.0268	0.0003	N.S.	N.S.

[1] Numbers in parentheses indicate percentages.
[2] N.S. = not significant.
* Significant difference between Eskimos and Aleuts, $P < 0.05$.

have been attributed to iron deficiency anemia resulting from a low dietary intake of iron, poor intestinal absorption of iron, and/or excess loss of iron due to infectious diseases (Steinbock, 1976; El-Najjar et al., 1976; Goodman et al., 1984; Ortner and Putschar, 1985). Frequencies of cribra orbitalia and porotic hyperostosis previously reported for native Alaskan skeletal samples vary considerably, ranging from 6.1% (cribra orbitalia and porotic hyperostosis combined) (El-Najjar, 1976) to 20% of Alaskan Eskimos (cribra orbitalia only) (Nathan and Haas, 1966), a difference that may reflect, in part, methodological differences and the differing proportion of subadults in the samples (Stewart, 1979). In the present study, the frequencies of the 2 conditions in the Eskimo sample are consistent with the observation of Scott et al. (1984: 70) that porotic hyperostosis “is not uncommon” in pre-contact and early contact period Alaskan Eskimo crania.

That both the Eskimos and Aleuts suffered from iron deficiency anemia prior to contact is contrary to what might be expected, given the primary reliance of these groups on a diet rich in iron. In fact, as Kent (1986) points out, if Nathan and Haas’ (1966) figure of 20% is accurate, then the northern coastal Eskimos display higher frequencies of cribra orbitalia and porotic hyperostosis than some horticultural Indian populations

from the American Southwest. Many of the foods traditionally utilized by the Eskimos and Aleuts, including sea mammal meat, blood soups, bone marrow, liver, waterfowl, and certain species of fish, contain iron in sufficient quantities to prevent anemia (Morehouse, 1981). Only in modern native Alaskan populations has anemia been attributed largely to an inadequate dietary intake of iron (Scott et al., 1955; Scott and Heller, 1964; Sauberlich et al., 1972). Thus diet is unlikely to have been the primary cause of iron deficiency anemia in the pre-contact period, although seasonal food shortages, known to have occurred among both groups (Fortuine, 1989), may have contributed, in part, to the development of this condition.

Parasitic, bacterial, and viral infections associated with sedentism and aggregation may account for the presence of iron deficiency anemia in Eskimos and Aleuts, since iron deficiency anemia appears to represent a positive adaptation to high pathogen loads (Stuart-Macadam, 1992). Parasitic infections have been proposed as a contributing factor in the development of iron deficiency anemia in Indian populations of coastal British Columbia (Cybulski, 1977) and California (Walker, 1986). Parasites are known to have afflicted Alaskan Eskimos and Aleuts prior to contact. Close contact with animals and their waste products predisposed both groups to a variety of zoonotic and parasitic infections (Fortuine, 1989). Alaskan mummies contain a number of parasites, some of which may have been capable of producing anemia in these individuals. These include the fish-borne parasite *Cryptocotyle lingua* (Zimmerman and Smith, 1975) and the mammal-borne parasites *Trichinella spiralis* (Zimmerman and Aufderheide, 1984) and *Echinococcus granulosus* (Ortner and Putschar, 1985).

Also associated with sedentism and aggregation are bacterial and viral infections (Kent, 1986). The occupation by the Eskimos and Aleuts of permanent winter villages, some of which were quite large, the lack of sanitation in these villages, and the reliance on water supplies that may have been contaminated (Fortuine, 1989) undoubtedly placed these groups at an increased risk of gastrointestinal infections resulting in diarrhea and the subsequent loss of iron. Diarrheal infections caused by the bacteria *Salmonella typhosa* and *Shigella flexneri* are common among modern Eskimo groups, particularly among children (Fournelle et al., 1958, 1959, cited in Oswalt, 1967: 77; Gordon and Babbott, 1959, cited in Oswalt, 1967: 76), and were likely present in earlier times as well (Oswalt, 1967: 77). In the early 19th century, diarrhea is reported to have been common among the Aleuts, who traditionally used a root extract as a remedy for this condition (Veniaminov, 1984).

The lack of a significant difference between the Eskimo and Aleut samples with respect to cribra orbitalia and porotic hyperostosis suggests that both groups were equally at risk of developing iron deficiency anemia prior to contact. Factors that made both groups susceptible to anemia included their heavy reliance on fish and sea mammal meat, foods known to carry parasites, seasonal food shortages, and exposure to bacterial and viral infections resulting from their unhygienic living conditions.

Trauma

Traumatic injuries “were a major cause of pain, disability, and death in pre-contact times” (Fortuine, 1989: 45). Some of these injuries were accidentally sustained during subsistence pursuits or the performance of other day-to-day activities. Others were intentionally inflicted during skirmishes between groups, e.g., between the Koniag Eskimos and Aleuts (Laughlin, 1980), as a result of altercations within groups, as occurred among the northern coastal Eskimos (Burch, 1974) and among the Aleuts (Levashov, cited in Masterson and Brower, 1948: 59), or as punishment of slaves and prisoners of war, a practice recorded for the Aleuts (Veniaminov, 1984).

Previous paleopathological studies of Alaskan Eskimos and Aleuts reveal that these groups suffered from a variety of injuries in the past, including fractures (Ortner and Putschar, 1985; Tyson and Alcauskas, 1980; Zimmerman and Aufderheide, 1984; Hrdlička, 1941; Lobdell, 1980), dislocations (Ortner and Putschar, 1985), and amputations (Lobdell, 1980). Of the 4 types of trauma that can be detected in skeletal

remains (Ortner and Putschar, 1985), fractures have been reported most frequently from Alaska and were the most common type of trauma observed in the present study. Of particular interest was the finding that the Aleut sample had a significantly higher frequency of cranial trauma than the Eskimo sample.

Fractures increase with age, reflecting increased years at risk (Lovejoy and Heiple, 1981). Therefore, one might expect the Aleut sample to show a greater frequency of trauma than the Eskimo sample given that the former contains significantly more older adults (50+ years). When only younger adults (<50 years) were compared, however, the Aleut sample still exhibited a significantly higher frequency of cranial trauma than the Eskimo sample [4/17 adults (23.53%) vs. 1/67 adults (1.49%) ($\chi^2 = 8.16$, $P = 0.0054$)]. An examination of the physical and cultural environment of the Aleuts provides 2 possible explanations for this difference.

Cranial trauma in past populations has been interpreted as evidence of interpersonal violence (Walker, 1989; Stodder and Martin, 1992). Walker (1989), e.g., argued that the significantly higher frequency of cranial depression fractures in island populations compared to mainland populations of Californian Indians reflected ritualized fighting resulting from competition over limited food resources. Among the northern coastal Eskimos, interpersonal violence is believed to have been common prior to contact, although its exact frequency is unknown (Burch, 1974). That warfare was widespread among the Aleuts in prehistoric times is suggested by native oral tradition. According to native accounts, gathered by Father Ivan Veniaminov, who served as an Orthodox missionary in the eastern Aleutian Islands in the early 19th century, warfare between neighboring Aleut settlements and between Aleuts and mainland Eskimos was a frequent occurrence. The destruction of entire settlements and a significant population reduction long before contact with Russians are known (Veniaminov, 1984). Such accounts suggest that warfare may have been even more common among the Aleuts than among the northern coastal Eskimos. If warfare was responsible for the cranial trauma observed in these groups and if it did, in fact, play a more significant role in Aleut life, this might explain the significantly higher frequency of cranial trauma in the Aleut sample.

If warfare is the underlying explanation for the traumatic injuries observed in the Aleut sample, it is perhaps surprising that other indicators of interpersonal violence, namely perimortem and parry fractures, multiple fractures (Lahren and Berryman, 1984), and fractures of the facial bones (Walker, 1989), are uncommon or absent in this sample. This is all the more surprising because Aleuts are reported to have been frequently killed in warfare (Veniaminov, 1984). This suggests that other factors may also underlie the observed difference between the Eskimos and Aleuts.

As Dunn (1968: 224) notes, deaths from hunting accidents, among other factors, "have probably always weighed heavily in the population equation for Eskimos and other peoples of polar and subpolar regions." Among the Aleuts, subsistence pursuits, in particular, the custom of lowering men down cliffs or of climbing cliffs to obtain sea birds and their eggs from coastal rookeries (Lantis, 1984), may have placed them at greater risk of cranial trauma. Cranial depression fractures can result from falls or from being struck by falling rocks in coastal areas (Walker, 1989). This might account, in part, for the significantly higher frequency of cranial trauma in Aleut males compared to Eskimo males. However, such pursuits would also, presumably, result in significant infracranial injuries, yet there is no significant difference between the Eskimos and Aleuts in infracranial trauma. This suggests that additional, unidentified factors underlie the patterns of trauma seen in these groups.

Infections

Infectious diseases believed to have been present in the New World prior to contact include tuberculosis and other respiratory infections, treponematosis, gastrointestinal diseases, and staphylococcal, streptococcal, and fungal infections (Merbs, 1992). A variety of these infectious diseases are also found in pre-contact Alaskan Eskimos and

Aleuts, including respiratory infections such as lobar pneumonia (Zimmerman et al., 1971, 1981; Zimmerman and Aufderheide, 1984) and bronchiectasis (Zimmerman et al., 1971; Zimmerman and Aufderheide, 1984), fungal infections such as histoplasmosis (Zimmerman and Smith, 1975; Zimmerman and Aufderheide, 1984), parasitic diseases (Zimmerman and Smith, 1975; Zimmerman and Aufderheide, 1984), and ear infections (Zimmerman et al., 1981; Lobdell, 1980).

Infections in bone can be classified as either specific or non-specific, the latter being more common in archeological remains (Goodman et al., 1984). In the present study, all affected individuals in the samples had non-specific infections, most likely bacterial infections caused by streptococcal or staphylococcal bacteria. *Staphylococcus aureus* has been identified as the primary causative organism in almost 90% of cases of osteomyelitis (Ortner and Putschar, 1985), while *Streptococcus* and other coccal organisms such as *Pneumococcus* and *Meningococcus* are responsible for the remaining 10% (Steinbock, 1976).

One young adult male from Kugusugaruk (Point Barrow area) displayed evidence of a possible respiratory infection in the form of active periostitis on the pleural surfaces of the fourth, fifth, eighth, and ninth right ribs and on the seventh left rib. Rib periostitis has been attributed to pleuritis (Schultz, 1989, cited in Wakely et al., 1991), an inflammation of the pleura. One possible cause of pleuritis is pulmonary tuberculosis (Kelley and Micozzi, 1984). Examinations of 2 well-documented skeletal collections have demonstrated an association between rib periostitis and this disease. Of the remains of individuals known to have died of tuberculosis, 8.8% in the Hamann-Todd Collection and 61% in the Terry Collection displayed rib lesions (Kelley and Micozzi, 1984; Wakely et al., 1991). As Wakely et al. (1991: 188) note, however, "the existence of such lesions in human osteoarchaeological specimens . . . [is] not pathognomonic of pulmonary tuberculosis in the affected individual." Other conditions that can produce rib lesions include trauma, pneumonia, and other non-tuberculous lung diseases (Kelley and Micozzi, 1984; Pfeiffer, 1991; Wakely et al., 1991).

A number of chronic lung conditions have been documented in the frozen and mummified remains of pre-contact Eskimos and Aleuts. These include emphysema (Zimmerman et al., 1971), fibrosis (Zimmerman et al., 1981; Zimmerman and Aufderheide, 1984; Zimmerman and Smith, 1975), and anthracosis resulting from the inhalation of smoke from seal oil lamps and cooking fires (Zimmerman and Aufderheide, 1984; Zimmerman et al., 1971, 1981; Zimmerman and Smith, 1975). Certainly the lack of conclusive evidence of tuberculosis in the Eskimo and Aleut samples is consistent with previous paleopathological studies of arctic populations, and with the general consensus that this disease was introduced to these populations by Europeans (De Laguna, 1956; Hrdlička, 1931; Oswalt, 1967; Lantis, 1984).

Of particular interest in the present study was the finding that the Aleut sample had a significantly higher frequency of infracranial infection by individual and by element than the Eskimo sample. Older adults are generally more susceptible to infections than young adults due, in part, to their weaker immune responses (Mims, 1987). Therefore, given that the Aleut sample contains significantly more older adults (50+ years) than the Eskimo sample, one might expect it to show a greater frequency of infection. When only younger adults (<50 years) were compared, however, the Aleut sample exhibited a higher frequency of infection by element [13/135 (9.63%) vs. 8/603 (1.33%) ($\chi^2 = 24.58$, $P = 0.0000$)], but not by individual. This suggests that factors other than age are responsible.

The type of housing utilized by the Eskimos and Aleuts provides one possible explanation for this difference. At the time of contact, the Aleuts occupied large, semisubterranean dwellings that were used throughout much of the year. These dwellings are reported to have contained anywhere from 30 or 40 to several hundred individuals at one time (Levashov, cited in Masterson and Brower, 1948; Makarova, 1975), although early houses appear to have been smaller (McCartney, 1984). Such crowded living conditions may have facilitated the spread of

infections among the occupants of these dwellings (Fortuine, 1989). Saunders et al. (1992) have argued that the longhouses utilized by the Ontario Iroquoians prior to contact may have predisposed them to infections, while in Sarawak, higher incidences of leprosy and tuberculosis have been documented in individuals living in longhouses than in those living in single family houses (Chen, 1988).

Compounding the increased opportunity for infection created by the crowded living conditions was the lack of sanitation within and around these houses. Numerous historical accounts attest to the lack of both personal and community hygiene in the early contact period. Both Cook (1967) and Sarychev (1807) commented on the fact that garbage and human waste were deposited in the middle of these dwellings. This refuse, combined with the lack of ventilation and uncomfortably high temperatures within these houses, undoubtedly provided the opportunity for potentially harmful viruses and bacteria to thrive.

In contrast to the Aleuts, the northern coastal Eskimos traditionally occupied smaller, single-room dwellings accommodating an average of only 8 individuals (Burch, 1981; Spencer, 1984). These houses, utilized during the winter months, were replaced in the summer by skin tents, each housing one family (Murdoch, 1988). Although the winter houses were reported to have been poorly ventilated and hot (Maguire, 1969), and their entranceways filled with human and other refuse (Beechey, 1831; Spencer, 1959; Murdoch, 1988), the lack of crowding in these dwellings may have reduced the spread of infection among their occupants. This might account for the lower levels of infection in the Eskimo sample.

While housing practices may underlie, to some extent, the difference between the 2 samples in infracranial infection, they do not explain the significantly higher frequency of infracranial infection in Aleut males compared to Eskimo males and the lack of a significant difference between Eskimo and Aleut females. One possibility is that some of the infectious lesions recorded in the Aleut males were the result of trauma, infection being one of the complications of trauma (Ortner and Putschar, 1985). While there was no statistically significant difference between Eskimo and Aleut males in infracranial trauma, it is possible that some of the infracranial infections seen in the Aleut males were the result of soft tissue trauma.

Dental pathology

A study of dental pathology can provide important clues to the general level of health and nutritional status of a population (Waldram et al., 1995). As expected, in both samples, abscesses, antemortem tooth loss, and periodontal disease were significantly more common in older individuals, reflecting an increase in these forms of dental pathology with age. Particularly noteworthy in the present study was the finding that the Eskimo sample had a significantly higher frequency of enamel hypoplasia by individual and by tooth count than the Aleut sample. Ranging from 1.36% (2/147 teeth) in the Aleut sample to 17.22% (67/389 teeth) in the Eskimo sample, the frequencies of enamel hypoplasia in the study samples are significantly lower than that of 63.4% (175/276 teeth) previously reported for a pre-contact Eskimo sample from St. Lawrence Island (Scott and Gillispie, n.d., cited in Scott et al., 1984). One possible explanation for this discrepancy is the use of different criteria for scoring enamel hypoplasia. Previous research has demonstrated that analyses of enamel hypoplasia in the same skeletal sample by different researchers can yield very different results (Pfeiffer and Fairgrieve, 1992, cited in Berti, 1992) due to the lack of a standard minimum defect size considered a hypoplasia (Goodman et al., 1980; Goodman and Rose, 1990).

Enamel hypoplasia is considered to be a non-specific indicator of systemic stress and provides a permanent marker of stress episodes occurring during infancy and childhood (Goodman et al., 1984). Of the more than 100 different factors that have been linked to the development of this condition (Cutress and Suckling, 1982), seasonal nutritional stress has been suggested as a possible explanation for enamel hypoplasia in pre-contact Eskimo remains from Kachemak Bay, Alaska (Lobdell, 1980). While both

the Eskimos and Aleuts are known to have experienced seasonal food shortages (Fortuine, 1989), the significantly higher frequency of enamel hypoplasia in the Eskimo sample suggests that this group may have been more susceptible to periodic food shortages than the Aleuts. Alternatively, other unidentified factors may have placed the Eskimos at increased risk of physiological stress during childhood.

Only 1 tooth of 1,840 (0.05%) examined in the Eskimo sample exhibited a carious lesion. This figure is lower than frequencies previously reported for other pre-contact Eskimo samples, which range from 3.5% of teeth in Kodiak Island Eskimos from Jones Point to 14.4% of teeth in Ipiutak Eskimos from Point Hope (Costa, 1980a). The rarity of tooth decay in Eskimo populations has been attributed to heavy attrition and the subsequent removal of areas prone to caries development, such as pits and fissures (Goldstein, 1932), and to the lack of refined sugars and starches in their traditional diet (Costa, 1980a). These factors most likely account for the lack of caries recorded in the present study as well. Both samples exhibited high attrition rates, with the majority of teeth showing moderate wear (Table 5), and the pre-contact diet of both groups was characterized by an absence of refined sugars and carbohydrates.

Previous studies of antemortem tooth loss in pre-contact Alaskan Eskimo remains have yielded frequencies ranging from 5.5% to 18.3% of teeth (Costa, 1980b). In the present study, approximately 18% of teeth had been lost antemortem in both the Eskimo and Aleut samples. In Eskimo populations, antemortem loss of the anterior dentition has been attributed to heavy attrition and accidental trauma caused by the use of these teeth as tools (Merbs, 1968; Costa, 1980b), while antemortem loss of the posterior teeth has been linked to heavy attrition and periodontal disease (Costa, 1980b). The high rate of attrition in the study samples undoubtedly played a significant role in the loss of teeth in both groups. Abscesses and periodontal disease, although less common, may also have contributed to the loss of teeth in these groups, particularly the molar teeth, which were most frequently affected by these conditions.

The frequencies of abscessed teeth recorded in the Eskimo and Aleut samples (6.03% and 6.90% of teeth, respectively) are not significantly different from those reported by Costa (1980a). Possible causes of dental abscesses include trauma, caries, and attrition (Hillson, 1986). Of these conditions, attrition has been identified as the most significant cause of abscesses in pre-contact Eskimo remains (Leigh, 1925; Costa, 1980a). Given the high level of attrition in the Eskimo and Aleut samples and the almost complete absence of caries, attrition was likely a major factor in the development of abscesses in both groups.

In the present study, 8.12% of teeth (201/2,474) in the Eskimo sample and 9.82% of teeth (92/937) in the Aleut sample showed evidence of periodontal disease. These figures are consistent with those recorded by Clarke et al. (1986) for an Alaskan Eskimo sample (8.9% of teeth). When calculated by individual, approximately 43% of Eskimos and 47% of Aleuts had periodontal disease, figures that fall within the range reported by Costa (1982) for the pre-contact Ipiutak and Tigara Eskimos from Point Hope. Consistent with Costa's (1982) results was the finding that the disease was more prevalent in older individuals. While the etiology of adult periodontal disease is still poorly understood, predisposing factors include poor oral hygiene, diet, tooth crowding, and attrition (Hillson, 1986; Hildebolt and Molnar, 1991). The lack of a significant difference between the Eskimo and Aleut samples in the frequency of periodontal disease by individual and by tooth count suggests that similar factors are underlying this condition in both groups.

CONCLUSIONS

The problems of making inferences about the health of past populations from skeletal remains are well recognized. Limitations of paleopathological data are recognized (Wood et al., 1992). Nevertheless, paleopathological data can provide some insight into patterns of health and disease in past populations, particularly when multiple indicators of stress are employed (Goodman, 1993) and

TABLE 5. Degree of dental attrition by tooth

	Eskimos				Aleuts			
	None	Slight	Moderate	Severe	None	Slight	Moderate	Severe
Males	0/1,097 (0.00)[1]	335/1,097 (30.54)	447/1,097 (40.75)	315/1,097 (28.71)	0/479 (0.00)	56/479 (11.69)	279/479 (58.25)	144/479 (30.06)
Females	0/708 (0.00)	299/708 (42.23)	331/708 (46.75)	78/708 (11.02)	0/323 (0.00)	45/323 (13.93)	158/323 (48.92)	120/323 (37.15)
Younger individuals	0/1,406 (0.00)	625/1,406 (44.45)	626/1,406 (44.52)	155/1,406 (11.02)	0/306 (0.00)	70/306 (22.88)	204/306 (66.67)	32/306 (10.46)
Older individuals	0/399 (0.00)	9/399 (2.26)	152/399 (38.10)	238/399 (59.65)	0/496 (0.00)	31/496 (6.25)	233/496 (46.98)	232/496 (46.77)
Incisors	0/329 (0.00)	87/329 (26.44)	172/329 (52.28)	70/329 (21.28)	0/101 (0.00)	10/101 (9.90)	63/101 (62.38)	28/101 (27.72)
Canines	0/252 (0.00)	73/252 (28.97)	125/252 (49.60)	54/252 (21.43)	0/114 (0.00)	7/114 (6.14)	82/114 (71.93)	25/114 (21.93)
Premolars	0/490 (0.00)	182/490 (37.14)	212/490 (43.27)	96/490 (19.59)	0/260 (0.00)	28/260 (10.77)	169/260 (65.00)	63/260 (24.23)
Molars	0/734 (0.00)	292/734 (39.78)	269/734 (36.65)	173/734 (23.57)	0/327 (0.00)	56/327 (17.13)	123/327 (37.61)	148/327 (45.26)
Maxilla	0/886 (0.00)	322/886 (36.34)	370/886 (41.76)	194/886 (21.90)	0/383 (0.00)	49/383 (12.79)	192/383 (50.13)	142/383 (37.08)
Mandible	0/919 (0.00)	312/919 (33.95)	408/919 (44.40)	199/919 (21.65)	0/419 (0.00)	52/419 (12.41)	245/419 (58.47)	122/419 (29.12)
Total	0/1,805 (0.00)	634/1,805 (35.12)	778/1,805 (43.10)	393/1,805 (21.77)	0/802 (0.00)	101/802 (12.59)	437/802 (54.49)	264/802 (32.92)

[1] Numbers in parentheses indicate percentages.

when the data are used in conjunction with other sources of information on health, such as archeological, historical, and epidemiological data (Goodman, 1993; Herring, 1992; Larsen, 1994).

Clearly, many aspects of the physical and cultural environment provided conditions favorable for the outbreak and spread of diseases among the northern coastal Eskimos and Aleuts prior to contact. As the data obtained in the present study indicate, both groups suffered from a variety of health problems, including iron deficiency anemia, fractures, non-specific infections, and dental pathology. Thus the data substantiate Fortuine's (1989) reconstruction of the health of these groups at the time of contact. They are also consistent with previous studies of skeletal populations from elsewhere in North and South America, which have indicated a substantial disease load prior to contact (Aufderheide, 1992; Larsen, 1994; Verano and Ubelaker, 1992).

Previous studies have indicated that pathogens introduced by Europeans may have had a more detrimental impact on populations whose health was already compromised (Milner, 1992). The decline in health that occurred among the Aleuts following contact (Fortuine, 1989; Keenleyside, 1994) may have been exacerbated by their precarious health before contact. Thus by understanding pre-contact health, one can better interpret post-contact disease patterns.

The data obtained in the present study also indicate that the Eskimos and Aleuts had different patterns of health and disease in the pre-contact period. Most notably, the Aleuts had significantly higher frequencies of cranial trauma and infracranial infection than the Eskimos, while the Eskimos had a significantly higher frequency of enamel hypoplasia than the Aleuts. This difference is consistent with previous studies of skeletal samples from other regions of the New World which have demonstrated "considerable geographic variability" in disease patterns "in response to varying cultural factors" (Ubelaker and Verano, 1992: 280). Differences between the Eskimos and Aleuts in their physical environment, warfare practices, housing, and subsistence pursuits may

underlie this variability. The existence of differences in disease patterns exhibited by these groups is also consistent with observations of modern-day hunter-gatherer populations. Studies of the latter have revealed interpopulation differences in the rates of accidents, infection, and other causes of death, emphasizing the danger of making generalizations about patterns of health and disease in hunter-gatherers and of viewing them as a "homogeneous, cultural-genetic-ecological unity" (Dunn, 1968: 228). As the present study illustrates, variability in disease patterns can be identified between hunter-gatherer populations living in similar environments and exhibiting similar general lifestyles.

ACKNOWLEDGMENTS

I thank Shelley Saunders for her support, advice, and encouragement throughout this research. Thanks also go to David Damas, Peter Ramsden, and Ann Herring of the Department of Anthropology, McMaster University, and to Charles Merbs for their invaluable assistance in the preparation of the doctoral dissertation from which this article is derived. I am grateful to the following individuals in the Department of Anthropology, National Museum of Natural History, Smithsonian Institution: David Hunt and Carol Butler for allowing me access to the skeletal material, Doug Owsley, Bob Mann, and Don Ortner for their guidance and advice throughout this research, and Fran Albrecht for radiographing some of the pathological specimens. In addition, I thank Robert Park for his advice, and Emőke Szathmáry and 2 anonymous reviewers for their very helpful comments on earlier versions of this article.

LITERATURE CITED

Anderson DD (1984) Prehistory of North Alaska. In D Damas (ed.): Handbook of North American Indians, Vol. 5 (Arctic). Washington, DC: Smithsonian Institution Press, pp. 80–93.

Aufderheide AC (1992) Summary on disease before and after contact. In JW Verano and DH Ubelaker (eds.): Disease and Demography in the Americas. Washington, DC: Smithsonian Institution Press, pp. 165–166.

Bass WM (1987) Human Osteology: A Laboratory and Field Manual of the Human Skeleton. 3rd Ed. Special Publication No. 2. Columbia: Missouri Archeological Society.

Beckett S and Lovell NC (1994) Dental disease evidence for agricultural intensification in the Nubian C-Group. Int. J. Osteoarch. *4:*223–240.

Beechey FW (1831) Narrative of a Voyage to the Pacific and Beering's Strait, to Cooperate With the Polar Expeditions: Performed in His Majesty's Ship Blossom, Under the Command of Captain F.W. Beechey, R.N., F.R.S., etc., in the Years 1825, 1826, 1827, 1828. 2 Vols. Reprint 1968. New York: Da Capo Press.

Berti PR (1992) The contribution of maternal age, birth order and birth interval to variation in the prevalence of linear enamel hypoplasia. M.Sc. thesis. Guelph, Ontario, Canada: Department of Human Biology and Nutritional Sciences, University of Guelph.

Black FL (1975) Infectious diseases in primitive societies. Science *187:*515–518.

Burch ES Jr (1974) Eskimo warfare in northwest Alaska. Anthropol. Pap. Univ. Alaska *16(2):*1–14.

Burch ES Jr (1981) The Traditional Eskimo Hunters of Point Hope, Alaska: 1800–1875. Barrow, Alaska: North Slope Borough.

Chen PCY (1988) Longhouse dwelling, social contact and the prevalence of leprosy and tuberculosis among native tribes of Sarawak. Soc. Sci. Med. *26:*1073–1077.

Clarke NG, Carey SE, Srikandi W, Hirsch RS, and Leppard PI (1986) Periodontal disease in ancient populations. Am. J. Phys. Anthropol. *71:*173–184.

Collins HB (1929) Prehistoric Eskimo culture of Alaska. Explorations and Fieldwork of the Smithsonian Institution in 1929. Washington, DC: Smithsonian Institution Press.

Cook J (1967) The journals of Captain James Cook on his voyages of discovery. In JC Beaglehole (ed.): Vol. 3. The Voyage of the Resolution and Discovery 1776–1780 (2 Parts). Cambridge: Hakluyt Society.

Costa RL Jr (1980a) Incidence of caries and abscesses in archaeological Eskimo skeletal samples from Point Hope and Kodiak Island, Alaska. Am. J. Phys. Anthropol. *52:*501–514.

Costa RL Jr (1980b) Age, sex and antemortem loss of teeth in prehistoric Eskimo samples from Point Hope and Kodiak Island, Alaska. Am. J. Phys. Anthropol. *53:*579–587.

Costa RL Jr (1982) Periodontal disease in the prehistoric Ipiutak and Tigara skeletal remains from Point Hope, Alaska. Am. J. Phys. Anthropol. *59:*97–110.

Cutress TW and Suckling GW (1982) The assessment of noncarious defects of enamel. Int. Dent. J. *32:*117–122.

Cybulski JS (1977) Cribra orbitalia, a possible sign of anemia in early historic native populations of the British Columbia coast. Am. J. Phys. Anthropol. *47:*31–40.

De Laguna F (1956) Chugach Prehistory. Seattle: University of Washington Press.

Dubos R (1965) Man Adapting. New Haven: Yale University Press.

Dumond DE (1987) The Eskimos and Aleuts. 2nd Ed. London: Thames and Hudson.

Dunn FL (1968) Epidemiological factors: Health and disease in hunter-gatherers. In RB Lee and I DeVore (eds.): Man the Hunter. Chicago: Aldine Publishing, pp. 221–228.

El-Najjar MY (1976) Maize, malaria and the anemias in the pre-Columbian New World. Yearb. Phys. Anthropol. *20:*329–337.

El-Najjar MY, Ryan DJ, Turner CG, and Lozoff B (1976) The etiology of porotic hyperostosis among the prehistoric and historic Anasazi Indians of southwestern United States. Am. J. Phys. Anthropol. *44:*477–488.

Federation Dentaire International (1982) An epidemiologic index of developmental defects of dental enamel (DDE index). Int. Dent. J. *32:*159–167.

Ford JA (1959) Eskimo prehistory in the vicinity of Point Barrow, Alaska. Anthropol. Pap. Am. Mus. Nat. Hist. *47:*1–272.

Fortuine R (1986/87) Early evidence of infections among Alaskan natives. Alaska Hist. *2:*39–56.

Fortuine R (1989) Chills and Fever. Health and Disease in the Early History of Alaska. Fairbanks: University of Alaska Press.

Fournelle HJ, Wallace IL, and Rader V (1958) A bacteriological and parasitological survey of enteric infections in an Alaskan Eskimo area. Am. J. Public Health *48:*1489–1497.

Fournelle HJ, Rader V, and Allen C (1959) Seasonal study of enteric infections in Alaskan Eskimos. Public Health Rep. *74:*55–59.

Goldstein MS (1932) Caries and attrition in the molar teeth of the Eskimo mandible. Am. J. Phys. Anthropol. *16:*421–430.

Goodman AH (1993) On the interpretation of health from skeletal remains. Curr. Anthropol. *34:*281–288.

Goodman AH and Armelagos GJ (1985) Factors affecting the distribution of enamel hypoplasias within the human permanent dentition. Am. J. Phys. Anthropol. *68:*479–493.

Goodman AH and Rose JC (1990) Assessment of systemic physiological perturbations from dental enamel hypoplasias and associated histological structures. Yearb. Phys. Anthropol. *33:*59–110.

Goodman AH, Armelagos GJ, and Rose JC (1980) Enamel hypoplasias as indicators of stress in three prehistoric populations from Illinois. Hum. Biol. *52:*515–528.

Goodman AH, Martin DL, Armelagos GJ, and Clark G (1984) Indications of stress from bone and teeth. In MN Cohen and GJ Armelagos (eds.): Paleopathology at the Origins of Agriculture. Toronto: Academic Press, pp. 13–49.

Gordon JE and Babbott FL (1959) Acute intestinal infection in Alaska. Public Health Rep. *74:*49–54.

Herring DA (1992) Toward a reconsideration of disease and contact in the Americas. Prairie Forum *17:*153–165.

Hildebolt CF and Molnar S (1991) Measurement and description of periodontal disease in anthropological studies. In MA Kelley and CS Larsen (eds.): Advances in Dental Anthropology. Toronto: Wiley-Liss, pp. 225–240.

Hillson S (1986) Teeth. Cambridge: Cambridge University Press.

Hrdlička A (1931) Anthropological work on the Kuskokwim River, Alaska. Washington, DC: Smithsonian Institution Explorations and Fieldwork, pp. 123–134.

Hrdlička A (1941) Diseases of and artifacts on skulls and bones from Kodiak Island. Smithson. Misc. Collect. *101:*1–14.

Hrdlička A (1942) Catalogue of human crania in the United States National Museum Collections: Eskimo in general. U.S. Natl. Mus. Proc. *91(3131):*169–429.

Hrdlička A (1945) The Aleutian and Commander Islands and Their Inhabitants. Philadelphia: Wistar Institute of Anatomy and Biology.

Iscan MY, Loth SR, and Wright RK (1984) Age estimation from the ribs by phase analysis: White males. J. Forensic Sci. *29:*1094–1104.

Iscan MY, Loth SR, and Wright RK (1985) Age estimation from the ribs by phase analysis: White females. J. Forensic Sci. *30:*853–863.

Keenleyside A (1994) Skeletal Evidence of Health and Disease in Pre- and Post-Contact Alaskan Eskimos and Aleuts. Unpublished Ph.D. dissertation. Hamilton, Ontario, Canada: Department of Anthropology, McMaster University.

Kelley MA and Micozzi MS (1984) Rib lesions in chronic pulmonary tuberculosis. Am. J. Phys. Anthropol. *65:* 381–386.

Kent S (1986) The influence of sedentism and aggregation on porotic hyperostosis and anaemia: A case study. Man (New Series) *21:*605–636.

Lahren CH and Berryman HE (1984) Fracture patterns and status at Chucalissa (40SY1): A biocultural approach. Tenn. Anthropol. *9:*15–21.

Lantis M (1984) Aleut. In D Damas (ed.): Handbook of North American Indians, Vol. 5 (Arctic). Washington, DC: Smithsonian Institution Press, pp. 161–184.

Larsen CS (1994) In the wake of Columbus: Native population biology in the postcontact Americas. Yearb. Phys. Anthropol. *37:*109–154.

Larsen CS and Milner GR (eds) (1994) In the Wake of Contact: Biological Responses to Conquest. New York: Wiley-Liss.

Larsen HE and Rainey F (1948) Ipiutak and the arctic whale hunting culture. Anthropol. Pap. Am. Mus. Nat. Hist. *42:*1–478.

Laughlin WS (1963) Eskimos and Aleuts: Their origins and evolution. Science *142(3593):*633–645.

Laughlin WS (1980) Aleuts: Survivors of the Bering Land Bridge. Toronto: Holt, Reinhart & Winston.

Laughlin WS and Aigner JS (1975) Aleut adaptation and evolution. In W Fitzhugh (ed.): Prehistoric Maritime Adaptations of the Circumpolar Zone. Paris: Mouton, pp. 181–201.

Leigh RW (1925) Dental pathology of the Eskimo. Dent. Cosmos *67:*884–898.

Lippold LK (1966) Chaluka: The economic base. Arc. Anthropol. *3:*125–131.

Lobdell JE (1980) Prehistoric human population resource utilization in Kachemak Bay, Gulf of Alaska. Unpublished Ph.D. dissertation. Knoxville: University of Tennessee.

Lovejoy CO and Heiple KG (1981) The analysis of fractures in skeletal populations with an example from the Libben Site, Ottowa County, Ohio. Am. J. Phys. Anthropol. *55:*529–541.

MacMahon B and Pugh TH (1970) Epidemiology. Boston: Little, Brown.

Maguire R (1969) Narrative of Commander Maguire, wintering at Point Barrow. In S Osborn (ed.): The Discovery of the North-West Passage, by Capt. R. M'Clure [1857]. Edmonton: M.G. Hurtig Ltd., pp. 351–405.

Makarova RV (1975) Russians on the Pacific 1743–1799. R.A. Pierce and A. Donnelly (translators and eds.): Kingston, Ontario: The Limestone Press.

Mann RW and Murphy SP (1990) Regional Atlas of Bone Disease. Springfield, IL: Charles C Thomas.

Mann RW, Jantz RL, Bass WM, and Willey P (1991) Maxillary suture obliteration: A visual method for estimating skeletal age. J. Forensic Sci. *36:*781–791.

Mason JA (1930) Excavations of Eskimo Thule culture sites at Point Barrow, Alaska. Proc. XXIII Int. Congr. Am. New York, pp. 383–394.

Masterson JR and Brower H (1948) Bering's Successors 1745–1780. Contributions of Peter Simon Pallas to the History of Russian Exploration Toward Alaska. Seattle: University of Washington Press.

McCartney AP (1984) Prehistory of the Aleutian region. In D Damas (ed.): Handbook of North American Indians, Vol. 5 (Arctic). Washington, DC: Smithsonian Institution Press, pp. 119–135.

McGhee R (1976) Parsimony isn't everything: An alternative view of Eskaleutian linguistics and prehistory. Can. Archaeol. Assoc. Bull. *8:*62–81.

Mensforth RC, Lovejoy CO, Lallo J, and Armelagos GJ (1978) The role of constitutional factors, diet and infectious disease in the etiology of porotic hyperostosis and periosteal reactions in prehistoric infants and children. Med. Anthropol. *2:*1–59.

Merbs CF (1968) Anterior tooth loss in arctic populations. Southwest. J. Anthropol. *24:*20–32.

Merbs CF (1983) Patterns of Activity-Induced Pathology in a Canadian Inuit Population. Ottawa: National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 119.

Merbs CF (1992) A new world of infectious disease. Yearb. Phys. Anthropol. *35:*3–42.

Milner GR (1992) Disease and sociopolitical systems in late prehistoric Illinois. In JW Verano and DH Ubelaker (eds.): Disease and Demography in the Americas. Washington, DC: Smithsonian Institution Press, pp. 103–116.

Mims CA (1987) The Pathogenesis of Infectious Disease. 3rd Ed. London: Academic Press.

Morehouse KB (1981) Alaskan native diet and nutrition: An ethnohistorical view. M.A. thesis. Fairbanks: University of Alaska.

Murdoch J (1988) Ethnological Results of the Point Barrow Expedition. Washington, DC: Smithsonian Institution Press.

Nathan H and Haas N (1966) "Cribra orbitalia." A bone condition of the orbit of unknown nature. Is. J. Med. Sci. *2:*171–191.

Ortner DJ (1992) Skeletal paleopathology: Probabilities, possibilities, and impossibilities. In JW Verano and DH Ubelaker (eds.): Disease and Demography in the Americas. Washington, DC: Smithsonian Institution Press, pp. 5–13.

Ortner DJ and Putschar WGJ (1985) Identification of Pathological Conditions in Human Skeletal Remains. Reprint edition of Smithsonian Contributions to Anthropology 28. Washington, DC: Smithsonian Institution Press.

Oswalt WH (1967) Alaskan Eskimos. New York: Chandler Publishing.

Oswalt WH (1979) Eskimos and Explorers. California: Chandler & Sharp.

Patterson DK Jr (1984) A Diachronic Study of Dental Palaeopathology and Attritional Status of Prehistoric Ontario Pre-Iroquois and Iroquois Populations. Ottawa: National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 122.

Pfeiffer S (1991) Rib lesions and new world tuberculosis. Int. J. Osteoarch. *1:*191–198.

Pfeiffer S and Fairgrieve S (1992) Evidence from ossuaries: The effect of contact on the health of Iroquoians. Paper presented at the 61st Annual Meeting of the American Association of Physical Anthropologists, Las Vegas, Nevada, April 1–4.

Rainey F (1947) The whale hunters of Tigara. Anthropol. Pap. Am. Mus. Nat. Hist. *41:*229–283.

Roberts CA and Manchester K (1995) The Archaeology of Disease. 2nd Ed. Ithaca, NY: Cornell University Press.

Rose JC, Anton SC, Aufderheide AC, Buikstra JE, Eisenberg L, Gregg JB, Hunt EE, Neiburger EJ, and Rothschild B (1991) Skeletal Database Committee Recommendations. Detroit: Paleopathology Association.

Salter E (1984) The Skeletal Biology of Cumberland Sound, Baffin Island, N.W.T. Unpublished Ph.D. dissertation. Ontario, Canada: University of Toronto.

Sarychev G (1807) The Voyage of Captain Sarychev Through Northeastern Siberia, the Arctic Sea, and the Eastern Ocean, Lasting Eight Years and Undertaken in Connection With the Geographic and Astronomic Naval Expedition Under Command of Captain Billings in the Years 1785–1793. St. Petersburg: Schnor.

Sauberlich HE, Goad W, Herman YF, Milan F, and Jamison P (1972) Biochemical assessment of the nutritional status of the Eskimos of Wainwright, Alaska. Am. J. Clin. Nutr. *25:*437–445.

Saunders SR, Ramsden PG, and Herring DA (1992) Transformation and disease: Precontact Ontario Iroquoians. In JW Verano and DH Ubelaker (eds.): Disease and Demography in the Americas. Washington, DC: Smithsonian Institution Press, pp. 117–125.

Schultz M (1989) Causes and frequency of diseases during early childhood in Bronze Age populations. In L Capasso (ed.): Advances in Palaeopathology. Chieti: Mario Solfanelli Editore, pp. 175–179.

Scott EM and Heller CA (1964) Iron deficiency in Alaskan Eskimos. Am. J. Clin. Nutr. *15:*282–286.

Scott EM, Wright RC, and Hanan BT (1955) Anemia in Alaskan Eskimos. J. Nutr. *55:*137–149.

Scott GR and Gillispie TE (n.d.) The dentition of the prehistoric inhabitants of St. Lawrence Island, Alaska. In R Menk (ed.): The Physical Anthropology of St. Lawrence Island.

Scott GR, Palmer DL, and Gillispie TE (1984) Cranial and dental observations on the Utqiagvik skeletons from Mound 44. Arct. Anthropol. *21:*65–76.

Smith BH (1984) Patterns of molar wear in hunter-gatherers and agriculturalists. Am. J. Phys. Anthropol. *63:*39–56.

Spencer RF (1959) The North Alaskan Eskimo. Washington, DC: U.S. Government Printing Office.

Spencer RF (1984) North Alaska Coast Eskimo. In D Damas (ed.): Handbook of North American Indians, Vol. 5 (Arctic). Washington, DC: Smithsonian Institution Press, pp. 320–337.

Stanford DJ (1976) The Walakpa Site, Alaska. Smithsonian Contributions to Anthropology 20. Washington, DC: Smithsonian Institution Press.

Steinbock RT (1976) Paleopathological Diagnosis and Interpretation. Springfield, IL: Charles C Thomas.

Stewart TD (1932) The vertebral column of the Eskimo. Am. J. Phys. Anthropol. *17:*123–136.

Stewart TD (1959) Skeletal remains from the vicinity of Point Barrow, Alaska. Eskimo prehistory in the vicinity of Point Barrow, Alaska. Anthropol. Pap. Am. Mus. Nat. Hist. *47:*245–255.

Stewart TD (1973) The People of America. London: Weidenfeld & Nicolson.

Stewart TD (1979) Patterning of skeletal pathologies and epidemiology. In WS Laughlin and AB Harper (eds.): The First Americans: Origins, Affinities and Adaptations. New York: Gustav Fischer, pp. 257–274.

Stodder ALW and Martin DL (1992) Health and disease in the southwest before and after Spanish contact. In JW Verano and DH Ubelaker (eds.): Disease and Demography in the Americas. Washington, DC: Smithsonian Institution Press, pp. 55–73.

Stuart-Macadam P (1992) Porotic hyperostosis: A new perspective. Am. J. Phys. Anthropol. *87:*39–47.

Suchey JM and Katz D (1986) Skeletal age standards derived from an extensive sample of modern Americans. Paper presented at the 55th Annual Meeting of the American Association of Physical Anthropologists, Albuquerque, New Mexico, April 1986.

Suchey JM, Brooks ST, and Katz D (1988) Instructional materials accompanying female public symphyseal models of the Suchey-Brooks system. Distributed by France Casting (Diane France, 2190 West Drake Road, Suite 259, Fort Collins, CO 80526).

Turner CG II, Aigner JS, and Richards LR (1974) Chaluka stratigraphy, Umnak Island, Alaska. Arc. Anthropol. *11(Suppl.):*125–142.

Tyson RA and Alcauskas ESD (eds) (1980) Catalogue of the Hrdlicka Paleopathology Collection. San Diego: San Diego Museum of Man.

Ubelaker DH (1989) Human Skeletal Remains. 2nd Ed. Washington, DC: Taraxacum.

Ubelaker DH and Verano JW (1992) Conclusion. In JW Verano and DH Ubelaker (eds.): Disease and Demography in the Americas. Washington, DC: Smithsonian Institution Press, pp. 279–282.

Utermohle CJ (1984) From Barrow Eastward: Cranial Variation of the Eastern Eskimo. Unpublished Ph.D. dissertation. Tempe: Department of Anthropology, Arizona State University.

Veniaminov I (1984) Notes on the Islands of the Unalashka District. LT Black and RH Geoghegan (translators) and RA Pierce (ed.). Kingston, Ontario: The Limestone Press.

Verano JW and Ubelaker DH (eds.) (1992) Disease and Demography in the Americas. Washington, DC: Smithsonian Institution Press.

Wakely J, Manchester K, and Roberts CA (1991) Scanning electron microscopy of rib lesions. Int. J. Osteoarch. *1:*185–189.

Waldram JB, Herring DA, and Young TK (1995) Aboriginal Health in Canada: Historical, Cultural and Epidemiological Perspectives. Toronto: University of Toronto Press.

Walker PL (1986) Porotic hyperostosis in a marine-dependent California Indian population. Am. J. Phys. Anthropol. *69:*345–354.

Walker PL (1989) Cranial injuries as evidence of violence in prehistoric southern California. Am. J. Phys. Anthropol. *80:*313–323.

Way JE (1978) An Osteological Analysis of a Late Thule/Early Historic Labrador Eskimo Population. Unpublished Ph.D. dissertation. Ontario, Canada: University of Toronto.

Wood JW, Milner GR, Harpending HC, and Weiss KM (1992) The osteological paradox: Problems of inferring prehistoric health from skeletal samples. Curr. Anthropol. *33:*343–370.

Zegura SL (1975) Taxonomic congruence in Eskimoid populations. Am. J. Phys. Anthropol. *43:*271–284.

Zimmerman MR and Aufderheide AC (1984) The frozen family of Utqiagvik: The autopsy findings. Arct. Anthropol. *21:*53–64.

Zimmerman MR and Smith GS (1975) A probable case of accidental inhumation of 1600 years ago. Bull. N.Y. Acad. Med. *51:*828–837.

Zimmerman MR, Yeatman GW, and Sprinz H (1971) Examination of an Aleutian mummy. Bull. N.Y. Acad. Med. *47:*80–103.

Zimmerman MR, Trinkaus E, LeMay M, Aufderheide AC, Reyman TA, Marrocco GR, Ortel RW, Benitez JT, Laughlin WS, Horne PD, Schultes RE, and Coughlin EA (1981) The paleopathology of an Aleutian mummy. Arch. Pathol. Lab. Med. *105:*638–641.